

Bryophytic Diversity of Bouknadel's Exotic Gardens (Morocco): New Species

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ABSTRACT

The Bouknadel's Exotic gardens, created by French horticultural engineer Marcel François in 1951, are located on flat and bare ground between the cities of Kénitra and Salé at 13 km in the north of Rabat (Morocco). They occupy an area of 4.5 ha and are characterized by a microclimate with high level of relative humidity. Arborescent, shrubby and herbaceous species coming from various tropical countries have acclimatized very well in these gardens creating interesting artificial and different ecosystems. The aim of this study is to provide an exhaustive list of bryophyte species that have settled in these diversified environments. For this purpose, 25 surveys were carried out from 2014 to 2016 and have resulted in the identification of 30 species. The phylum mosses is represented by 27 taxa divided into 7 families and 17 genera and that of the Liverworts by only 3 species affiliated with 3 families and 3 genera. Comparison with previous work has shown the presence of a new species and a new variety for Morocco, namely *Ptychostomum moravicum* (Podp.) Ros & Mazimpaka and *Ptychostomum pseudotriquetrum* (Hedw.) JR Spense & HP Ramsay var. *pseudotriquetrum*. We also identified two new species for the region of Rabat: *Leptodictyum riparium* (Hedw.) Warnst. and *Tortella tortuosa* (Hedw.) Limpr. The observations have shown that *Ptychostomum capillare* Hedw. is the most common species in these gardens followed by *Lunularia cruciata* (L.) Dum, then *Fissidens bryoides* Hedw. Nearly 33% of the collected species belongs to the family of Pottiaceae, 20% to the family of Bryaceae, and almost 17% to the family of Brachytheciaceae. These plants settle mainly on rock faces or on wet soil, sometimes on tree trunks, and on the edges of ponds. The specific richness of bryophytes inside the Exotic gardens is considerably higher than outside the gardens because of the high level and permanent moisture that support the propagation of these nonvascular plants.

Keywords: Bryophytes, Liverworts, Mosses, biodiversity, Bouknadel's Exotic gardens, Morocco.

INTRODUCTION

The Bouknadel's Exotic Gardens are a nationally well-known tourist attraction. Marcel François, a French horticultural engineer passionate about botany, created it in 1951 on a flat and bare ground of 4.5 hectares. He opened these gardens to the public after ten years of development and, in 1973, he conceded it to the Moroccan government. Currently, these gardens are under the protection of "Mohamed VI Foundation for the Protection of the Environment". They contain more than 600 vascular species acclimated from 5 continents. These plants profit from great importance and are highly cared for by managers compared to the neglected bryophytes.

The Exotic Gardens are characterized by a particular microclimate due to the proximity of the ocean on one

side and the lush vegetation that grows inside on the other. This microclimate favors the installation and diversification of the bryophytic flora.

Bryophytes represent an important component of plant biodiversity; in the world, they constitute the second plant phylum after flowering plants with about 25,000 species (Crum 2001, Mishler 2001).

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The Moroccan bryoflore is beginning to arouse the interest of researchers throughout the Kingdom. The present study is a contribution in the framework of a global study aiming to identify the specific diversity of bryophytes in Morocco. For this purpose, we have carried out an exploration of the Exotic gardens of Bouknadel with the aim of compiling an exhaustive list of bryophytic species.

MAERIAL AND METHODS

Field of study

The Exotic gardens of Bouknadel are located on the national road between Salé and Kénitra, to 13 km north of Rabat, with an average altitude of 42 m a.s.l. (Figure 1). The climate of this zone is mediterranean of sub-humid type with temperate to hot variant according to the bioclimatic synthesis (M'Hirit, 1999). The annual rainfall is between 500 and 600 mm and is spread over an average of 78 days a year; the number of dry months varies between 5 and 6 months (El Gharbaoui, 1987). The atmospheric humidity reaches its maximum in winter; El Gharbaoui in 1987 stated that the relative air humidity in Rabat, the closest station to our site, is 71.5% in winter, 64% in spring, 64.5% in summer and 62% in autumn. The installation in this site of artificial ponds, falls, drains, rock outcrops, has created a great diversity of media (rocks, land, sand, dead wood).

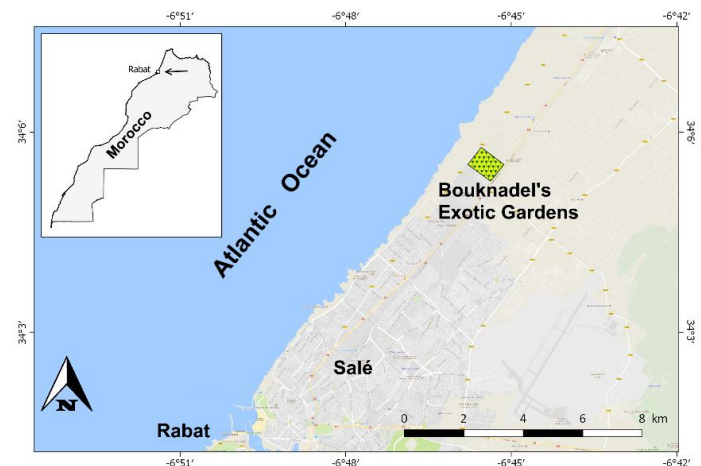
Figure-1. locates the Exotic gardens on a map built in a GIS software (QGIS 2.18) with a background layer coming from Google's web service.

The harvest of bryophytes in Exotic Gardens of Bouknadel was carried out during the months of March and April 2014, January 2015 and February 2016. The first season was the most favorable period to observe the majority of species in the best conditions, especially with the sporophyte that is necessary for identification; the other seasons allowed us to complete sample collection. Figure 2 shows the course of sampling where a sample is collected from each encountered stand.

Sampling:

The harvested samples are dried in open air and kept in herbarium pending their identification. They are carefully studied using a binocular loupe first and then using an optical microscope; we took photos for illustration.

Figure-1. Location of Bouknadel's Exotic gardens



We identified the collected samples in laboratory using Augier (1966), Boulay (1884 and 1904), Pierrot (1982), Smith (1990 and 2004), Coudreuse (2005) and Casas et al. 2006). We realized identification by observing all the macroscopic and microscopic characters of samples by referring to the characters described in the determination keys. After this step, each we kept species in a herbarium according to the technique described by Augier (1966). For each species, we calculated the frequency of presence by the ratio between the number of surveys where it occurs and the total number of surveys carried out on the site, which is 25.

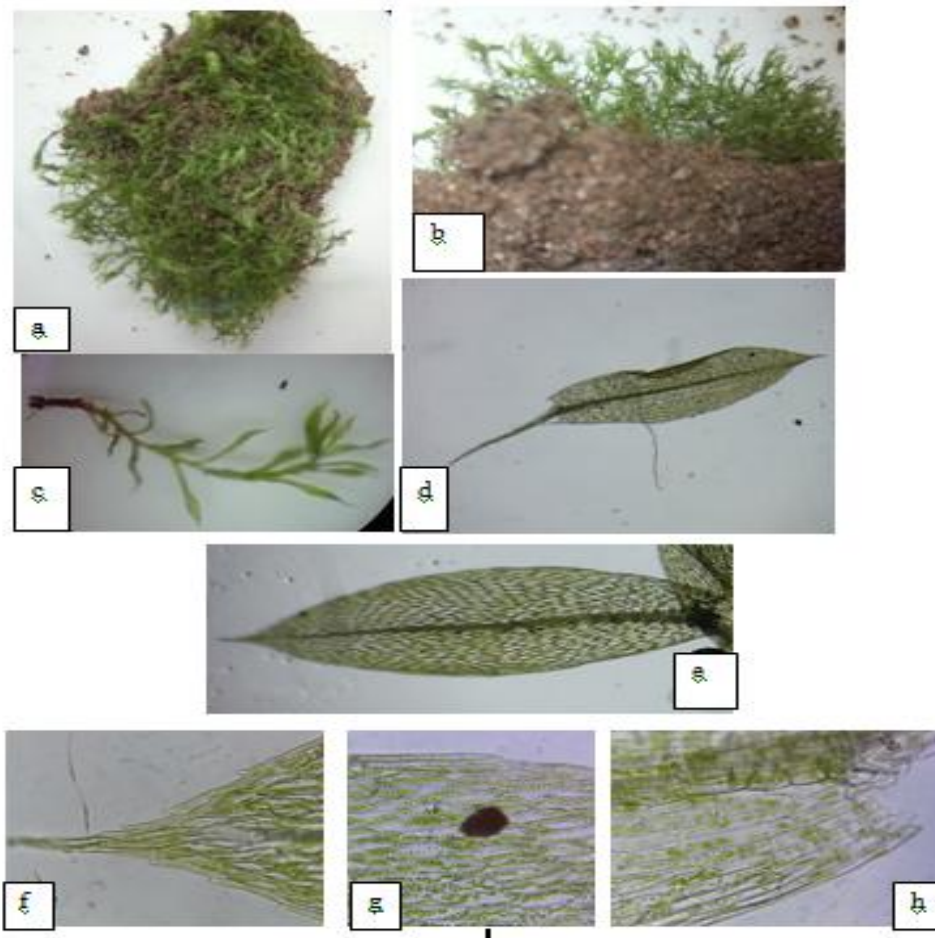
RESULTS AND DISCUSSION

The study of bryoflore of Exotic Gardens of Bouknadel revealed 30 species. We have recorded 27 species in the Phylum of Muscinea, related to 7 families and 18 genera. For liverworts, only 3 species were identified belonging to 3 families and 3 genera. Within the first group, the genus *Ptychostomum* is the most represented with 4 species of which *Ptychostomum capillare* is the most widespread, it settles on calcareous rocks and earthy soil of the studied site. In the second group, *Lunularia cruciata* has the most recovery; it occupies rock walls and moist earthy soil.

Figure 2: Illustration of Exotic Garden of Bouknadel



Figure 3: *Ptychostomum moravicum*: a) tuft (x5), b) tuft with substrate (x10), c) isolated individual (x30), d) leaf (x20), e) leaf (x40), f) apical cells of limb (x100), g) median cells of limb (x100), h) basal cells of limb (x100)



Two species are considered new for Morocco according to the comparison with identification keys that we used (Augier 1966, Boulay 1884 and 1904, Pierrot 1974, Smith 1990 and 2004, Coudreuse 2005 and Casas et al. 2006) and inventories and catalogs of Bryophytes carried out in Morocco (Ahayoun et al., 2013) and in the Mediterranean region (Ros et al., 2013). These are *Ptychostomum moravicum* (Podp.) Ros & Mazimpaka (Figure 3) and *Ptychostomum pseudotriquetrum* (Hedw.) J.R. Spense & H.P. Ramsay var. *pseudotriquetrum* (Figure 4), both belong to the family of Bryaceae.

Concerning *Ptychostomum moravicum* (Podp.) Ros & Mazimpaka, it is the synonym of *Bryum capillare* var. *flaccidum* auct. non (Brid.) Bruch & Schimp. and *Bryum capillare* var. *flaccidum* (Brid.) Bruch & Schimp in Ros et al, (2013). *Bryum capillare* species has already been mentioned in Morocco (Braun-Blanquet, 1954, Jelenc, 1955a, Jovet-Ast, 1955d, Jelenc, 1967, cited by Ros et al., 1999); on the other hand, *Bryum capillare* var. *flaccidum* (Brid.) Bruch & Schimp has never been mentioned in Morocco. We can therefore consider *Ptychostomum moravicum* as a new taxon for Morocco.

Moreover, for the species *Psychostomum pseudotriquetrum*, it is synonymous of:

- *Bryum pseudotriquetrum* var. *duvalioides* cited in Tangelois region (Pitard, 1913, cited by Gattefossé &

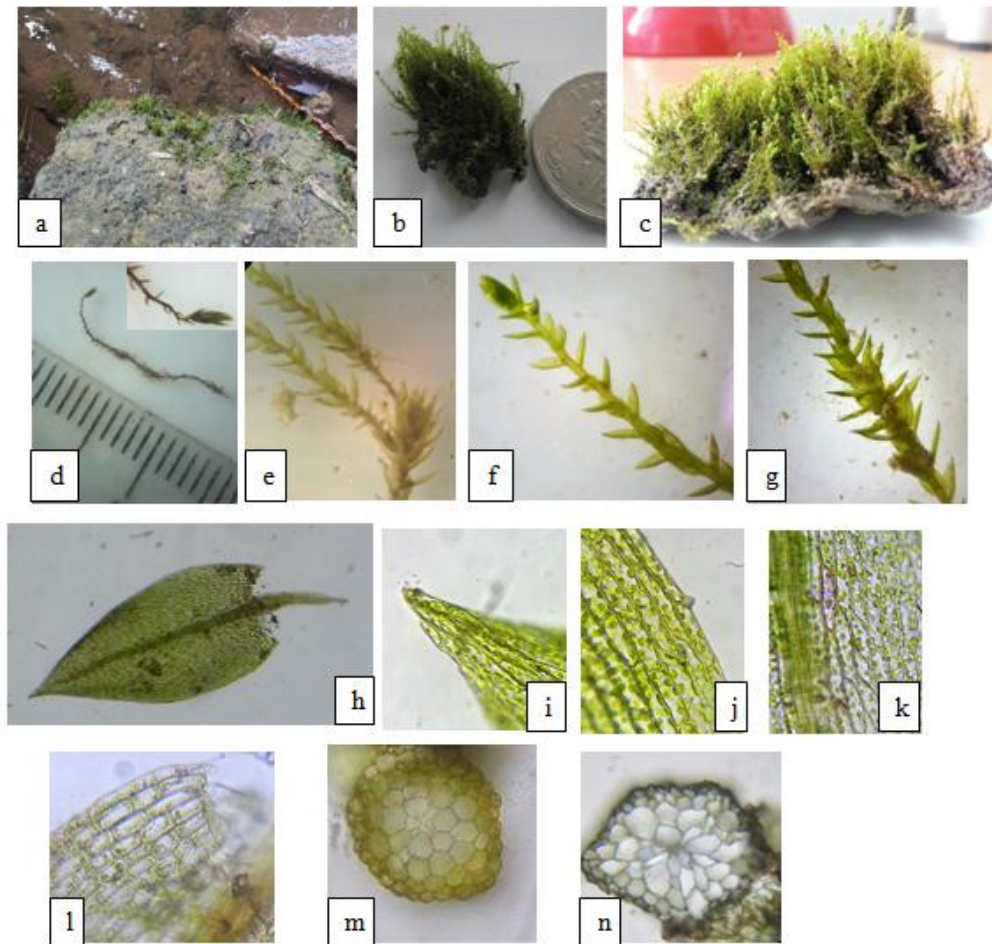
Werner, 1932, then Braun-Blanquet, 1954, Jelenc, 1955a, cited by Ros et al., 1999)

- *Bryum pseudotriquetrum* (Hedw.) P.Gaertn., B. Mey. & Scherb, found in Camp Monod (currently Sidi Allal El Bahraoui) (Corbière, 1913)
- *Bryum ventricosum* Dicks., Found in Camp Monod (currently Sidi Allal El Bahraoui) (Corbière, 1913)
- *Bryum ventricosum* var. *flaccidum* (Schimp) Jelenc cited in Tangelois region (Pitard, 1913, cited by Gattefossé & Werner, 1932, then Braun-Blanquet, 1954, Jelenc, 1955a, quoted by Ros et al., 1999).

It should be noted that the variety *Ptychostomum pseudotriquetrum* (Hedw.) J.R. Spense & H.P. Ramsay var. *pseudotriquetrum* has never been mentioned in Morocco as such. On the other hand, it is synonymous with the species *Bryum neodamense* (Ros et al 2013), observed and identified during this study in Exotic Gardens and never mentioned in Morocco. The identification process led us to *Bryum neodamense* but we will adopt the name of *Ptychostomum pseudotriquetrum* (Hedw.) J.R. Spense & H.P. Ramsay var. *pseudotriquetrum* by referring to the catalog of Mediterranean Mosses of Ros et al. (2013) (Figure 4).

For the newly observed species in Rabat region, two taxa have been identified: *Leptodictyum riparium* (Hedw.) Warnst. (Syn. *Amblystegium riparium* (Hedw.) Schimp.) (Figure 5) and *Tortella tortuosa* (Hedw.) Limpr. (Figure 6).

Figure 4: *Ptychostomumpseudotriquetrum* var. *pseudotriquetrum*: a) Plant in situ, b) tuft (real size), c) humidified plant (real size), d) leafy stem (x5), e) leafy stem branched basal (x 20), f and g) apical part of stem (x 20), h,i and j) leaf (x 40), k) marginal cells of leaf (x400), l) median cells of leaf (x400), m) apical cells of leaf x400, n) young stem in cross-section (x400), o) aged stem in cross-section (x400)



Leptodictyum riparium (Hedw.) Warnst has been cited in Morocco in Middle Atlas and Anti-Atlas by Jelenc, 1955a and Jelenc, 1967 quoted by Ros et al. (1999). *Tortella tortuosa* (Hedw.) Limpr. (Syn. *Barbula tortuosa* (Hedw.) F. Weber & D. Mohr.) has been cited in Morocco in Rif and Middle Atlas (Braun-Blanquet, 1954 and Jelenc, 1954 cited by Ros et al., 1999) (Draper et al., 2005).

The floristic analysis revealed that the most commonly encountered species are *Psychostomum capillare* (48%), *Lunularia cruciata* (40%), *Fissidens bryoides* (36%) and *Rhynchostegiella tenella* (32%). Thirteen taxa are only encountered in one survey as shown in Figure-8. The most represented family is Pottiaceae with 10 species. Most species settle in moist habitats, on limestone rock walls or on earthy soil; only one species is sub-aquatic, which is *Riccia fluitans* (Figure-7). Figure 8 shows the frequency of occurrence of each of the listed species, which is the number of surveys where it appears, while Figure-9 reveals the species richness per survey.

The richest species records are those that are shaded or close to water surfaces and waterfalls; on the other hand, those who are poor in species are more exposed to the sun (Figure 9). Some species are more common such as

Ptychostomum capillare, which appears in 12 surveys (Figure-8).

List of species found in Bouknadel's exotic gardens

The species are presented by Class and by Family. The nature of the substrate is mentioned for each species. Information on the substrate and the ecology of the species from the bibliographic data is placed in braces. The species and variety newly encountered in Morocco are preceded by the symbol *. The species observed for the first time in the region of Rabat-Salé-Kénitra are preceded by the symbol °.

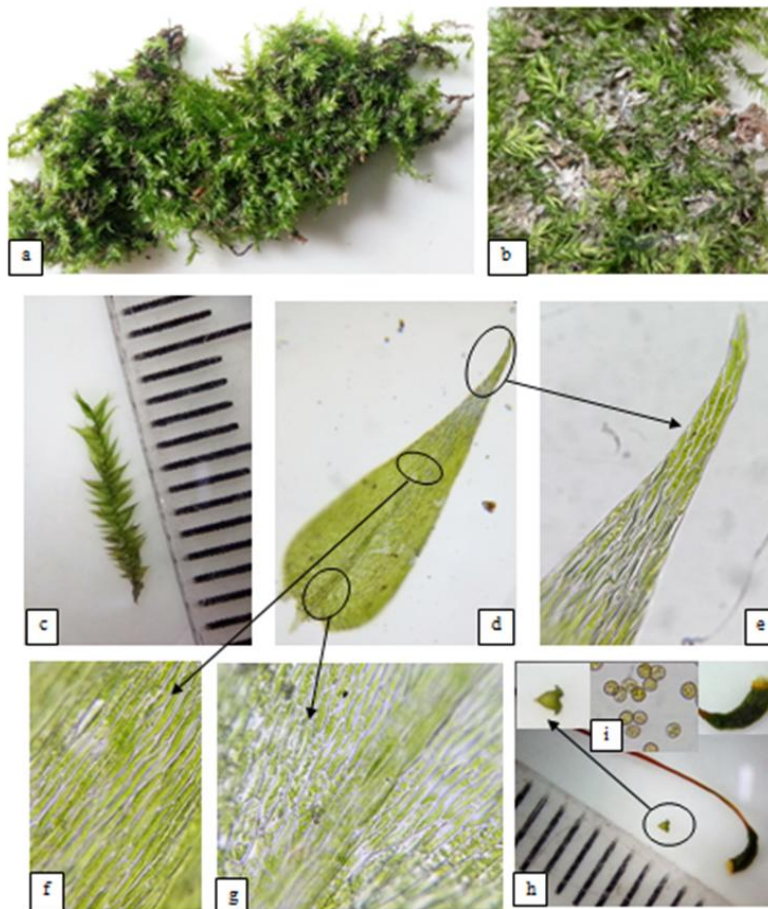
Phyllum of Muscinea (Bryophyta)

Family: Amblystegiaceae

° *Leptodictyum riparium* (Hedw.) Warnst (*Amblystegium riparium* (Hedw.), *Amblystegium leptophyllum* Schimp., *Amblystegium maderense* (Mitt.) Jaeg., *Hypnum riparium* Hedw.): On calcareous rocks near small water surfaces and falls of the study site. [On wet, submerged or indifferent stones and woods (Augier, 1966); and on stones and woods that are frequently flooded or submerged in rather calm waters, at the edges of ditches, ponds or swamps, wet rotting stumps,

indicative of significant organic and/or ammoniacal tree trunks, in the cracks of rocks, on slopes, in hedges,

Figure-5: *Leptodictyum riparium*: a) tuft (real size), b) tuft (x2), c) leafy stem (x 5), d) leaf (x40), e) apical cells of limb, f) median cells of limb, g) basal cells of limb (x400), h) sporophyte (x10) with enlarged operculum (top left) and enlarged capsule (top right), i) spores (x100).



pollution (Coudreuse et al. 2005)].

Family: Brachytheciaceae

Rhynchostegiella curviseta (Brid.) Limpr. (*Rhynchostegium curvisetum* Schimp., *Eurhynchium curvisetum* (Brid.) Husn.): On limestone shaded rocks and wet soil. [On limestone, on damp walls (Augier, 1966)].

Rhynchostegiella tenella var. *meridionalis* Boul. Zodda: On limestone rocks. [Shaded limestone rocks. old limestone walls (Augier, 1966)].

Rhynchostegium megapolitanum (Bland. ex F. Weber & D. Mohr) Schimp. (*Eurhynchium megapolitanum* (Bland ex F. Weber & D. Mohr) Milde): On clay-sandy soil [On rocky soil, on sands of littoral (Augier, 1966)].

Scorpiurum circinatum (Brid.) Fleisch. & Loeske (*Eurhynchium circinatum* (Brid.) Schimp.): On moist soil or on sunny limestone rocks. [On sand or sunny rocks, rather calcareous (Augier, 1966)].

Family: Bryaceae

Ptychostomum capillare Hedw.: On cut wood or on limestone shaded or on wet soil. [On old walls, foot of trees (Augier, 1966); and on ground, walls, at the base of

in woods (Boulay, 1884).

Ptychostomum torquescens (Bruch & Schimp.) Ros & Mazimpaka (*Bryum capillare* subsp. *icodense* (H. Winter) Podp., *Bryum capillare* subsp. *torquescens* (Bruch & Schimp.) Kindb., *Bryum capillare* var. *torquescens* (Bruch & Schimp.) Husn. *Bryum icodense* H. Winter, *Bryum torquescens* Bruch & Schimp.): On calcareous rock of the studied site [On rocks, on walls, on stony places especially limestone (Augier, 1966)]

***Ptychostomum moravicum* (Podp.) Ros & Mazimpaka** (*Bryum laevifilum* Syed, *Bryum flaccidum* auct. non. Brid., *Bryum subelegans* auct. non Kindb.): On earthy ground of the studied site [On soils, rocks, on walls and trunks, on oak, beech, pine and fir (Casas et al, 2006)].

Bryum radiculosum Brid (*Bryum murale* Wils, *Bryum murorum* (Schimp.) Berk, *Bryum eurythrocarpum* v. *murorum* Schimp): On moist limestone rocks; [On stony ground or on mortar walls or limestone (Augier, 1966); and in cracks and calcareous mortar of walls (Boulay, 1884)].

Ptychostomum pseudotriquetrum* (Hedw.) J.R. Spense & H.P. Ramsay var. *pseudotriquetrum (*Bryum neodamense* (Itzigs., *Bryum pseudotriquetrum* var. *cavifolium* Schimp.): On the edges of water surfaces, on very wet emergent rocks. [At the edges of streams, or

swamps or indifferent (Augier, 1966) and deep swamps, often flooded places (Boulay, 1984)].

Bryum caespitium Hedw. (*Bryum badium* (Brid.) Schimp., *Bryum comense* Schimp.): On the limestone

Figure-6: *Tortella tortuosa*: a) tuft (x2), b) leaf (x40), c) limb tip (x100), d) median part of limb (x100), e) hyaline part and chlorophyll part of limb (x100), f) marginal portion of limb (x100), g) hyaline cells (x400), h) cross-section of leaf (x100), i) sheet in cross-section (x 100).

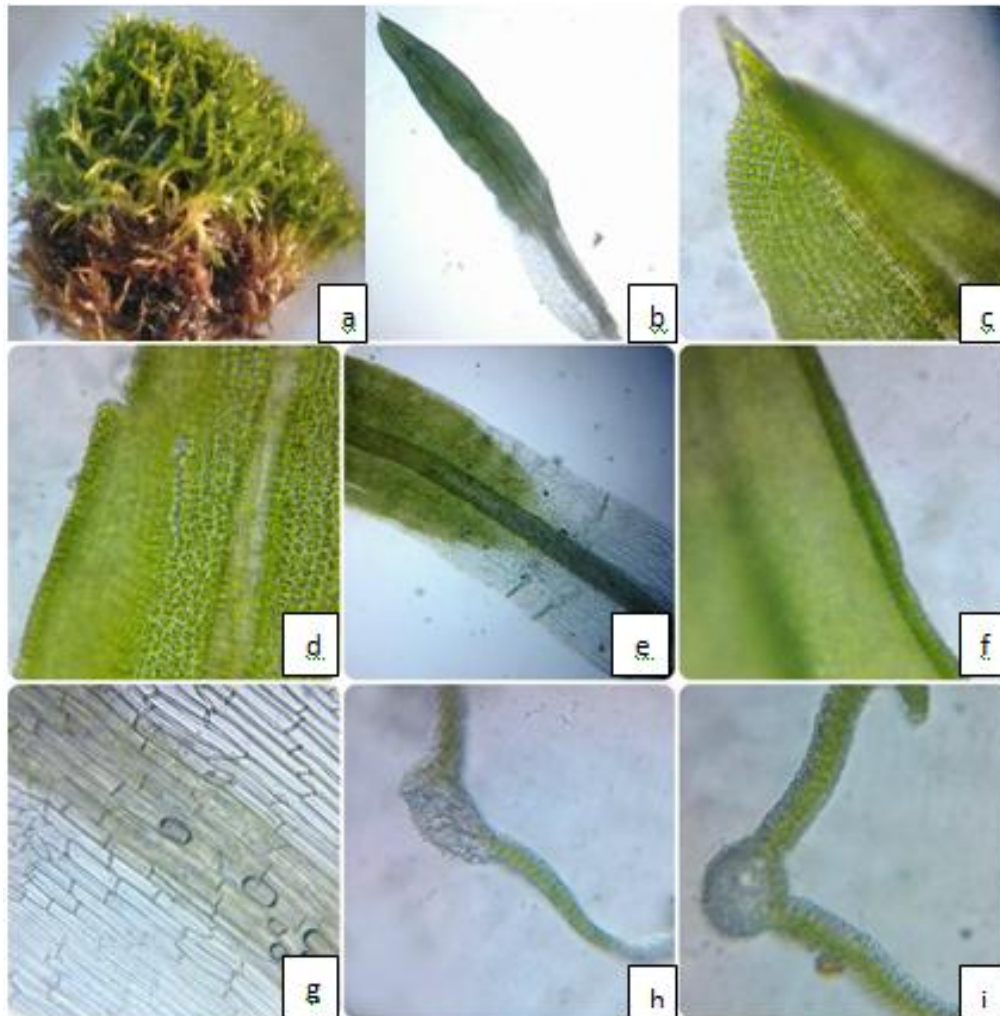
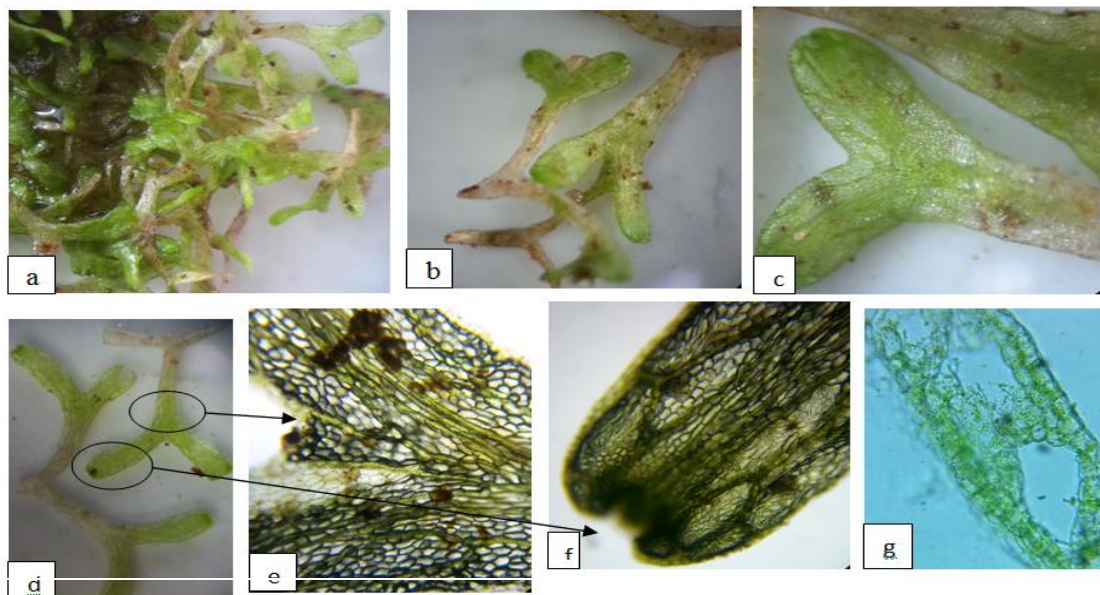


Figure 7: *Ricciafluitans*: a- thalli (x20), b- magnified thallus (x30), c- subdichotomic ramification (x40), d- ramified feet (x30), e- thallus cells (x100), f- tip of the thallus branch (x100), g- cross section of thallus (x400).



rocks of the studied site. [On basic or neutral ground, on ruins, banks, rocks, ancient walls, quarries and dunes (Smith, 2004); and on dry land, on sand (maritime, moors), on old walls, and indifferent (Augier, 1966)].

Figure-8. Frequency of occurrence for each identified species in Bouknadel's exotic gardens

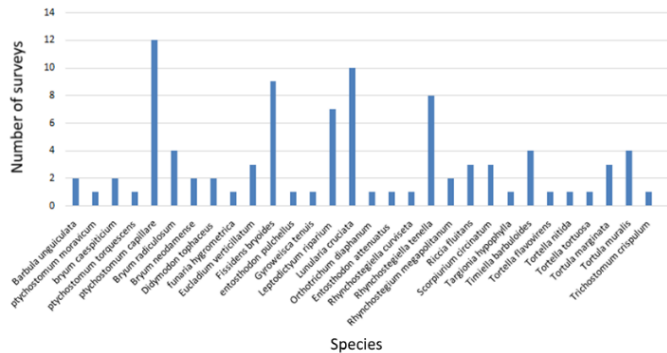
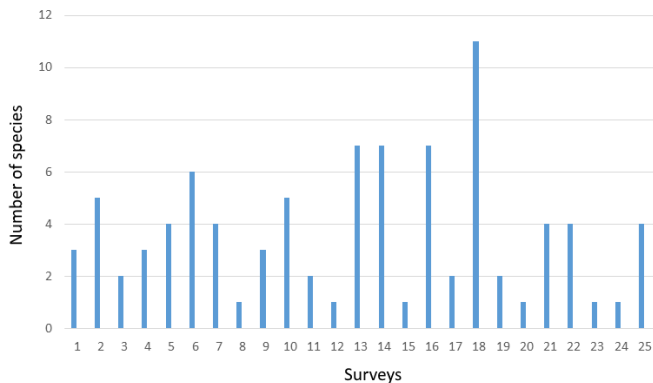


Figure-9. Number of species recorded in each survey carried out in Bouknadel's exotic gardens



Family: Fissidentaceae

Fissidens bryoides Hedw (*Hypnum bryoides*(Hedw.) L. ex With.): On wet limestone rocks and wet soils. [Non-calcareous shaded land (Augier, 1966) and on embankments, edges of paths, wet stones, hedges (Boulay, 1884)].

Family: Funariaceae

Funaria hygrometrica (*Funaria calvescens* Schwägr.,
Funaria hygrometrica var. *ahaggarensis* Thér. & Trab.,
Funaria hygrometrica var. *calvescens* (Schwägr.) Mont.,
Funaria hygrometrica var. *minor* Hartm., *Funaria*
hygrometrica var. *muralis* Huebener, *Funaria*
hygrometrica var. *patula* Bruch & Schimp., *Mnium*
hygrometricum (Hedw.) With.): On the wall of the studied
site [In gardens, on buildings and old walls, especially on
fire sites (Smith, 2004)].

Entosthodon attenuatus (Dicks.) Bryhn (*Funaria attenuata* (Dicks.) Lindb., *Entosthodon templetonii* (Sm.) Schwägr., *Funaria templetonii* Sm., *Physcomitrium soleirolii* Mont.: On wet ground of the studied site. [Acid soils acidified by streams, rock crevices and cornices, lowlands (Casas et al 2006); on moist soil by streams, ditches, forests, moors, cornices, cliffs (Smith, 2004) and on moist soil and between cracks in rocks (Augier, 1966)].

Entosthodon pulchellus (H. Philib.) Brugués (*Funaria pulchella* H. Philib.): between cracks of limestone rocks of the studied site. [Cracks on granitic rocks at 2100 m a.s.l. (Ros et al., 2000); and on basic soils in meadow and between rocks, calcicole (Smith, 2004)].

Family: Orthotricaceae

Orthotrichum diaphanum (Gmel.) Schrad: On tree trunk in the studied site. [On isolated trees, on rocks and walls (Augier, 1966) and on tree trunks, more rarely on stones, mainly in the vicinity of houses, along public walks (Boulay, 1884)].

Family: Potticaeae

Barbula unguiculata (Huds.) Hedw: On limestone rocks of the studied site and on clay-sandy soil. [Pioneer on argillaceous soil and calcareous sand, messicole (Augier, 1966); on old walls, on moist and clayey soil of fields and meadows, on the banks of ditches, on sandy or stony hills, on all kinds of terrain (Boulay 1884)].

Didymodon tophaceus (Brid) (*Trichostomum tophaceum* Brid, *Barbula tophacea* (brid) Mitt): At the edge of water surface, on wet limestone rocks; [On wet limestone rocks, tuffs (Augier, 1966)].

Eucladium verticillatum (Brid.) Bruch & Schimp. (*Weisia verticillata* Brid., *Mollia verticillata* Lindb): On very wet calcareous rocks. [On tufts, on oozing calcareous rocks (Augier, 1966) and on cracks in rocks and walls where seepage of water laden with carbonate of lime occurs (Boulay, 1884)].

Gyroweisia tenuis (Hedw.) Schimp. (*Weissia tenuis* (Hedw.) Müll. Hal.): At the edge of a small water surface, on wet limestone rock [On fresh calcareous walls, old walls (Augier, 1966)].

Timmiella barbuloidea Brid. (*Timmiella barbula* Limpr., *Trichostomum Barbula* Schwaegr): On moist limestone rocks; moist soil. [On limestone ground and rocks (Augier, 1966); and on clayey soil, a little bit cool, at the foot of rocks and walls and in ravines. (Boulay, 1884)].

Tortella flavovirens (Bruch) Broth. (*Trichostomum flavovirens* Bruch): On limestone rocks. [Sands (mostly maritime), crevices of rocks (Augier, 1966); and in sandy or stony places, in pine woods or undergrowth of the Mediterranean region (Boulay, 1884)].

Tortella nitida (Lindb.) Broth. (*Trichostomum nitidum* Schimp, *Trichostomum diffractum* mitt, *Tortula nitida* Lindb, *Trichostomum mutabile* v. *robustius* juratzk, *Barbula nitida* Grav, *Barbula alexandrina* Lor. Abhandl): On shaded limestone rocks. [On sunny limestone rocks (Augier, 1966) and mainly in the fissures and earthy joints of rocks uncovered or weakly shaded (Boulay, 1884)].

***Tortella tortuosa* (Hedw.) Limpr. (*Bryum tortuosum* Linn. = *Barbula tortuosa* Web. & Mohr, *Barbula subtortuosa* Mull. Ha, *Mollia thrausta* Stirt, *Tortula incrassata* Brid.):** On slightly humid ground. [Rocks and limestone, much rarer on silica (Augier, 1966) and in the cracks and walls of limestone rocks shaded and a little bit cool (Boulay, 1884)].

Tortula marginata (Bruch & Schimp.) Spruce (*Barbula marginata* Br): On limestone rocks of the studied site. [On sandstone rocks, old walls, limestone (Augier, 1966) and on walls, rocks, shady places (Boulay, 1884)].

Tortula muralis Hedw (*Barbula muralis* Timm, *Bryum murale* L.): On limestone rocks. [On walls, rocks, roofs (Augier, 1966); and on the top and sides of walls, on roof tiles, in the fissures of rocks, more rarely at the base of tree trunks (Boulay, 1884)].

Trichostomum crispulum Bruch.: On limestone rocks. [Pioneer on limestone rocks, on gravelly ground, coastal dunes (Augier, 1966) and on sandy or marly soil of hills, in the hollows of rocks, on old walls, on the fixed sands of ancient dunes; more common on limestone soils (Boulay, 1884)].

Class of Liverworts (*Marchantiophyta* ou *Hepatiquophyta*)

Family: Lunulariaceae

Lunularia cruciata (L.) Dum. (*Marchantia cruciata* L., *Lunularia vulgaris* Mich., *Lunularia michelii* Le Jolis, *Marchantia dillenii* Le Jolis, *Preissia cucullata* Mont. & Nees, *Staurophora pulchella* Willd): On rocks and shady wet ground at the edge of waterfalls and small water surfaces. [Wet ground, in sunken paths, gardens and greenhouses (Augier, 1966); on wet ground at the edge of streams, on wet ground, on rocks and old walls in sunken roads, along roadsides, in gardens and greenhouses (Coudreuse et al 2005)].

Family: Ricciaceae

Riccia fluitans L. (*Ricciella natans* Braun, *Ricciella fluitans* Braun, *Riccia canaliculata* Hoffm): Floating on the stagnant waters of small water surfaces or on very wet submerged rocks. [In calm water of ponds and ditches, and on mud, salt water (Augier, 1966) and in stagnant mesotrophic or eutrophic waters of ponds and ditches, on mud and banks (Coudreuse et al 2005)]

Family: Targioniaceae

Targionia hypophylla L. (*Targionia michelii* Cord): On clay-sandy soil. [Pioneer on clay soil, and calcareous sand, messicole (Augier, 1966) and on clay-sandy soil, on old walls and in their cracks, limestone rocks (Boulay, 1904)].

CONCLUSION

Bouknadel's Exotic gardens are a nationally known attraction for its exuberant biodiversity. The bryological component of this biodiversity, which is the subject of this study, has not benefited from any special management or care, unlike Spermatophytes.

Surveys carried out in the exotic gardens in 2014, 2015 and 2016 allowed us to draw up a list of 30 species of Bryophytes. Of the 27 species of mosses, *Ptychostomum capillare* is the most widespread species in the studied site where it settles on calcareous rocks and earthy soil. Although the environment has high moisture levels, only three Hepatic species have been observed including *Lunularia cruciata*, the most widespread species covering rocky walls and wet ground, and *Riccia fluitans*, the only aquatic species that we encountered.

The analysis of data allowed us to identify new species and variety for Morocco (*Ptychostomum moravicum* (Podp.) Ros & Mazimpaka and *Ptychostomum pseudotriquetrum* (Hedw.) J.R. Spense & H.P. Ramsay

pseudotriquetrum) and two new species for Rabat-Salé-Kénitra region (*Leptodictyum riparium* (Hedw.) Warnst. and *Tortella tortuosa* (Hedw.) Limpr.).

The most common species in the studied site are *Psychostomum capillare*, *Lunularia cruciata* and *Fissidens bryoides*, because they are fond of wet and shaded areas. On the other hand, the rare species that are only found in one survey are those with low ecological amplitude; they can only settle in specific environments. The majority of the studied species are therefore found in wet grounds of the Exotic gardens whether on ground, on rocks or on tree trunks. The specific richness of Bryophytes recorded in these gardens is remarkable for such a small area compared to lands surrounding the study area

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Conflicts of Interest

Authors declare that there is no conflict of interests regarding the publication of this paper.

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